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University of Tennessee Agricultural Experiment Station

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THIRTEENTH ANNUAL REPORT

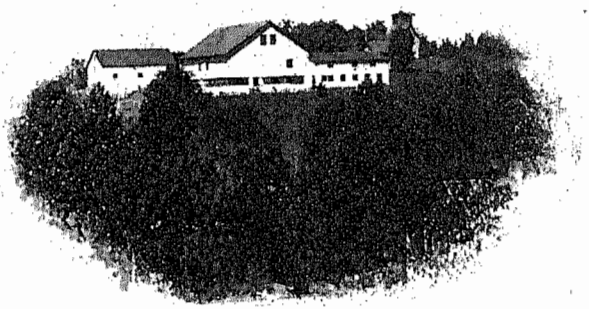
OF THE

Agricultural Experiment Station

OF THE

UNIVERSITY OF TENNESSEE

FOR 1900



BARNS, UNIVERSITY FARM

THE UNIVERSITY OF TENNESSEE PRESS
1900

THE AGRICULTURAL EXPERIMENT STATION

OF THE UNIVERSITY OF TENNESSEE

CHARLES W. DABNEY, *President*

EXECUTIVE COMMITTEE

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J. B. KILLEBREW
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J. W. CALDWELL
HARRIS BROWN

TREASURER
JAMES MAYNARD

SECRETARY
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STATION OFFICERS

CHARLES W. DABNEY, President
ANDREW M. SOULE, Vice-Director and Agriculturist
SAMUEL M. BAIN, Botanist
CHARLES A. KEFFER, Horticulturist
CHARLES A. MOOERS, Chemist
WESTON M. FULTON, Meteorologist
M. JACOB, V. S. Consulting Veterinarian
FREDERICK H. BROOME, Librarian
JOHN R. FAIN, Farm Manager
PHARES O. VANATTER, Assistant for Plat Work
GEORGE A. FLICKINGER, Dairyman
MISS ETHEL REESE, Stenographer

The station has facilities for analyzing and testing fertilizers, cattle foods, milk and dairy products; seeds with reference to their purity or germinating power; for identifying grasses and weeds, and studying forage plants; for investigating the diseases of fruits and fruit trees, grains and other useful plants.

Packages by express, to receive attention, should be prepaid.

All communications should be addressed to the

AGRICULTURAL EXPERIMENT STATION,
Knoxville, Tennessee.

☞The experiment station building, containing its offices, laboratories and museum, and the plant house and horticultural department, are located on the University grounds, 15 minutes walk from the Custom House in Knoxville. The experiment farm, dairy barn, stables, milk laboratory, etc., are located one mile west of the University, on the Kingston pike. Farmers are cordially invited to visit the buildings and experimental grounds.

Bulletins of this station will be sent, upon application, free of charge, to any farmer in the state.

REPORT OF THE AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF TENNESSEE FOR 1900

To His Excellency, Benton McMillin, Governor of Tennessee:

Sir: I have the honor to submit herewith a report of the work and expenditures of the agricultural experiment station of the University of Tennessee for the calendar year 1900.

The agricultural experiment station has continued to make great progress during the past year. A number of improvements have been made in buildings, the most important one being the erection of a dairy laboratory. This laboratory has been fully equipped with boiler, engine, and apparatus for milk testing and for butter and cheese making. This laboratory supplements the excellent dairy barn erected the year before and completes our equipment for experimental work in this line, and also enables us to give thorough instruction in all subjects connected with dairying.

At a recent meeting of the board of trustees the office of vice-director was established in the experiment station and Professor Andrew M. Soule was elected to the position. M. Jacob has been appointed consulting veterinarian of the experiment station. Otherwise, the officers remain as before.

An experimental fruit farm has been established upon the north farm of the University. The location is a desirable one for fruit and vegetables, being on the crest and sides of a ridge extending east and west and thus affords northern, eastern and southern slopes adapted to the growth of different kinds of plants. This farm has been planted to 44 varieties of seedling apples and several varieties of other apples, 12 of peach, five of plum, three of cherry, four of quince, and many varieties of strawberries, raspberries, blackberries, currants, and gooseberries. This farm will be further enlarged and other plantations will be made this season. The fruit farm consists of eight acres. The greenhouse of the horticultural department has been rebuilt and enlarged during the year and rooms for grafting and potting have been added.

During the past year the chemist of the experiment station has conducted some very interesting experiments with fertilizers

upon typical soils and with different crops. He plans to develop a series of cooperative experiments with farmers, which are sure to be profitable to them and interesting to all.

All of the officers of the agricultural experiment station and several of those from other departments of the University have aided in the work of farmers' institutes conducted by the state commissioner of agriculture. Two or more members of the University have thus attended 30 institutes during the two years. Through these meetings and through the publications of the agricultural department the work being done for practical agriculture, horticulture and dairying and that of the chemical and botanical laboratories has been made available for the farmers of the state, with the result that they are manifesting more interest in our experiments than ever before.

As a result of the admirable work of the experiment station an earnest desire is being manifested in both Middle and West Tennessee for a branch experimental farm under the direction of our officers. This is a compliment which we appreciate, and should the necessary land, buildings, equipment and funds be provided this board pledges itself now to furnish the proper scientific direction and supervision and to publish the results.

INSPECTION OF NURSERY STOCK

At the earnest solicitation of the growers of nursery stock the board of trustees authorized the entomologist of the experiment station several years ago to inspect such nurseries in the state as might apply for his assistance in protecting their trees against the San Jose scale and other pests. Neighboring states into which our growers ship their stock have laws requiring that the stock be inspected or certified as pure. A few nurseries in Tennessee have unfortunately become infected with the San Jose scale, with the result that all our stock is under suspicion. This assistance was rendered our growers as a means of guarding their nurseries and meeting the requirements of the state into which they shipped trees.

As this inspection could not be efficiently enforced without a law and a small appropriation to cover expenses the entomologist was instructed to draw up a law and submit it to the fifty-first general assembly. This was done and a law copied after that of our neighboring states was submitted to the agricultural committees of the general assembly. Although the matter was

earnestly advocated by the growers nothing was done with regard to it.

This board has never had any responsibility with regard to this matter, but only allowed its entomologist to inspect these nurseries for the accommodation and assistance of the owners of stock. It was soon found that without a law to enforce it this inspection amounted to nothing.

The entomologist of the station resigned on July 1, 1899, and owing to the pressure upon our means for other agricultural work no successor has yet been appointed. After the failure of our effort to secure a law and the resignation of the entomologist application was made to us by growers for private assistance in caring for their own stock, and Mr Chambliss, the former entomologist of the station, was authorized and consented to act in this capacity, provided the owners would meet the necessary expenses.

The experience of the last two years has taught us, however, that it is utterly impossible to accomplish anything with regard to this matter without legislative and financial support. There is nothing to prevent infected nurseries from shipping their trees into other states, with the result that the stock is destroyed and the reputation of all Tennessee stock greatly injured. Many thousand trees have recently been destroyed in this way in the state of Georgia. Under the circumstances this board can not afford to have any officer connected with it act in regard to the matter, and it has therefore been constrained to withdraw its inspector. It is wrong to try to do what it is impossible to do, especially when one is liable thereby to be held responsible for mistakes which can not be prevented.

The board would earnestly call the attention of the legislature to the apparent demands of the situation and assure you that it will give it pleasure to cooperate with the state whenever the means and the authority are provided. We can suggest nothing better for the protection of our nurseries than the act submitted to the last general assembly, a copy of which will be forwarded whenever asked for.

Four regular bulletins have been published during the year, as follows:

VOL. 13

No. 1 Frost protection. Climate of Tennessee.
2 Experiments with winter wheat.
3 Fertilizer experiments on potatoes, corn, cowpeas, peanuts and effects of fertilizers on the germination of seeds.
4 Feeding native steers.

Six press bulletins have also been published, as follows:

No. 14 Grades on country roads.
15 Calf feeding.
16 Live stock problems.
17 Winter gardening. Winter violets.
18 Advantages of dairying.
19 Formulas for spraying mixtures.

As a further means of interesting and instructing the farmers an agricultural handbook has been published and distributed to all persons applying for it. This handbook contains articles on subjects of practical importance to Tennessee farmers, fruit growers, dairymen and stockmen. The second number is now in the press. Copies of these handbooks, together with the bulletins and reports of the agricultural experiment station, have been mailed to every member of the general assembly as an exhibit connected with this report. You are requested to examine them carefully, as they furnish the best means of informing you with regard to the excellent work of this and the related departments.

As this is the last report of the century the president has prepared a history of the experiment station since its beginning. This experiment station was established by this board of trustees June 8, 1882, about five years before the Hatch experiment station act was passed by congress. While the national experiment station has completed its thirteenth year, the experiment station of this University has completed its eighteenth. The interesting history of this, which was one of the first stations established in America, is given in the paper attached hereto.

Attention is called to the reports of the agriculturist, botanist, horticulturist, chemist, librarian, and meteorologist appended to this report. Respectfully submitted for the board,

CHARLES W. DABNEY, President.

HISTORY OF THE TENNESSEE EXPERIMENT STATION 1882 TO 1900

The agricultural college was founded in 1869. The college farm was bought the same year. The agricultural experiment station of the University of Tennessee grew out of its school of agriculture, horticulture, and botany, which was founded in the year 1870. The first man in this chair was Prof. Hunter Nicholson.

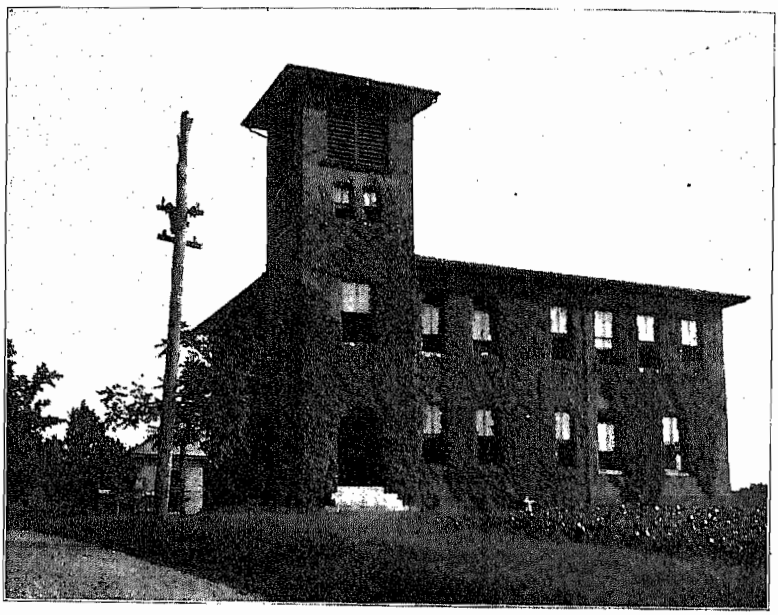
The first conception of an agricultural college was that of the manual labor school or a place where young men should be taught the practical operations of the farm. This policy never prevailed here, but for many years it was not understood anywhere what should be taught in such a college.

The experimental work of this school was established on a large scale by Prof. J. M. McBryde, now president of the Virginia college and director of its experiment station, who was at its head from June, 1879, to June, 1882. Much valuable experimental work was done during this period, and three reports of nearly 200 pages each were published giving the field experiments with wheat and feeding experiments conducted upon the farm. This work attracted wide attention and led to the establishment of the station as a department of the University on June 8, 1882. This was done by the board of trustees unaided from any source whatsoever. This action of the board under these circumstances and at this time exhibited a most patriotic and progressive spirit. The few other experiment stations in this country had been established with state appropriations. The board of trustees of the University of Tennessee was the first one and with the exception of Cornell university the only corporation who ever took upon themselves the responsibility of establishing a station without any special endowment. It was one of the first five experiment stations in America which by their good work fastened the attention of the people of the country and secured the magnificent recognition of this type of institution expressed by the Hatch experiment station act of congress. For this reason this action of the board of trustees deserves to be noted in the history of agricultural science in this country. According to the resolution of the board adopted at this time, the object of the experiment station was to be "the promotion of the agricultural interests of Tennessee by practical and scientific experimentation and investigation." This has been the guiding principle in the administration of this station, the advancement of Tennessee agriculture.

The only assistance ever received from the state was a small allowance made by the bureau of agriculture for defraying the expenses of analyses of fertilizers, soils and agricultural products made at the station for that bureau. This was only paid for a few years and ceased entirely in 1897.

Prof. John W. Glenn succeeded Dr McBryde as professor of agriculture, horticulture and botany, and became the first director of the station in June, 1882. He held the office until June, 1887. On July 24,

1887, Dr Chas. W. Dabney, director of the North Carolina station, was elected director of the Tennessee experiment station with authority to propose a plan and nominate officers for the reorganization of the station under the Hatch act. Prof. Chas. S. Plumb, now director of the Indiana experiment station, was appointed professor of agriculture and agriculturist to the station and entered upon his duties October 11, 1887. Dr W. E. Stone, now president of Purdue university, the land grant college of Indiana, was elected chemist, and Prof. F. Lamson-Scribner, now agrostologist of the United States department of agriculture, was chosen botanist and horticulturist. Dr Dabney served as director until 1890, when Prof. Scribner was elected director. He served until 1892. The staff was reorganized in July, 1892, at which time Dr Chas. W. Dabney



THE FARM OFFICE

was made director as well as president of the University, and Prof. Chas. F. Vanderford, who had succeeded Prof. Plumb as professor of agriculture, was made secretary. Prof. S. M. Bain, the present professor of botany and botanist of the station, succeeded Prof. Scribner in 1892. On the death of Prof. Vanderford, January 3, 1899, Prof. Andrew M. Soule was elected professor of agriculture and agriculturist of the experiment station, and he entered upon his duties May 1, 1899. Prof. R. L. Watts, who had been elected horticulturist, succeeded Prof. Vanderford as secretary of the experiment station. Prof. Watts resigned September 20, 1899, and was succeeded as professor of horticulture and horticulturist by Charles A. Keffer. F. H. Broome was appointed acting secretary and

continues to serve in this capacity. Lucius P. Brown succeeded Dr Stone as chemist, and he was followed by J. B. McBryde, who resigned July 1, and was succeeded by Chas. A. Mooers. To the chemist has been assigned recently the supervision of cooperative experiments with fertilizers. The station staff has been further strengthened by the addition of George A. Flickinger, assistant in charge of the dairy laboratory, and Phares O. Vanatter, assistant in charge of plot work.

The station is governed by the board of trustees, who appoint a committee to have immediate charge of its affairs. The staff consists of the president of the University, the agriculturist, botanist, horticulturist, chemist, farm manager, dairyman, plot expert, meteorologist, librarian and secretary, gardener, and stenographer. The president is the executive officer of the experiment station and directs the work of its different branches.

The station buildings consist of the Morrill Hall on the University grounds, an office building at the farm, a cottage, two barns, an old and a new one, a dairy building, a greenhouse, and some small farm buildings. Morrill Hall, the main building, was erected in part in 1882 and completed in 1888. It is a two-story brick building, the old part being 30x60 feet and the addition 40x60 feet, and contains the laboratories of chemistry, botany, horticulture and soil physics; the herbarium, museum, library, two lecture rooms, four offices, photographic department, etc. The office building at the farm contains work and seed rooms, office and laboratory, and some lodging rooms for the assistants. A frame cottage is occupied by the farm manager. The old barn contains the horse stable, the stable for fattening beef stock, mows for hay, fertilizer bins, and tool and implement rooms. The large new barn contains the cow stable, the silos, storage barn, and threshing and seed rooms; and a wing contains additional wagon and tool rooms and sheds for sheep and hogs. The green house has been recently enlarged by adding grafting and potting rooms thereto. The farm consists of two tracts known as the south farm or "college farm," consisting of a little over one hundred acres, and the north farm, consisting of nearly one hundred acres. The latter, which was unimproved for sometime, was recently turned over to the horticulturist and the chemist for a fruit and experimental farm. About one-half of this is still covered with a young forest growth. Ten acres have been planted in apples, cherries, quinces, plums, pears, etc. A hundred trees representing 40 varieties of Tennessee seedling apples are among the most interesting growths. Trial plantings of strawberries, blackberries, gooseberries, and currants have also been made. A vineyard is provided for experimental purposes.

The south farm is devoted to the experimental field work of the division of agriculture. Twenty acres are occcupied by a series of about eight hundred uniform test plats. Seventy acres are devoted to more extended field tests. The station owns 30 cows, four calves, six horses, three mules, 15 head of beef stock, and other stock purchased from time to time as necessity required. It also has a full equipment of agricultural implements of all kinds, including thresher, cutter and shredder, etc. The

General View of the Plats and the Road

new dairy building deserves special mention. It was erected and equipped during 1900 at an expense of $10,000. It is about 40x80 feet, with boiler and engine room 25x31 feet, and contains 4,000 square feet of floor space. It is a one-story brick building, with marble trimmings and cement floors, and contains nine rooms, each devoted to a special purpose. It is fully equipped with machinery for experimental dairy work, including milk and cream vats, separators, sterilizers, pasteurizers, bottling machines, churns, and butter workers. It has a refrigerator and cheese room. The building is heated throughout by steam and lighted by electricity.

The division of botany has an herbarium of 25,000 specimens, including a fine collection of fungi, 500 lantern slides, and full equipment of apparatus of all kinds for work in physiological botany. The station has also a collection of over 5,000 insects and 400 bottles of alcoholic materials.

The separate station library contains about 2,350 volumes and 3,500 pamphlets, besides 5,000 unbound bulletins and reports of other experiment stations and the United States department of agriculture. The station has also a collection of over 1,000 photographic negatives of experiments, plants, animals, etc., taken in the course of its work, which forms a valuable part of its record. It also has about 200 soil samples of Tennessee and many specimens illustrating the flora and fauna of the state.

The United States weather bureau has established a station at the University of Tennessee in connection with the station and equipped it in an admirable manner. The weather observer is meteorologist of the station and the equipment of the office is at the disposal of the station for its use. There is also an equipment of weather instruments at the station farm. The main features of the equipment of the station are shown in the accompanying illustrations of buildings, laboratories, and barns.

VALUE OF BUILDINGS AND EQUIPMENT OF THE AGRICULTURAL DEPARTMENT AND EXPERIMENT STATION

With the exception of a portion of the station building, which cost $2,500, and the old barn and the cottage at the farm, all of this equipment has been provided since the organization of the Hatch experiment station in 1888, and the bulk of it has been paid for from general funds of the University. The value of this building and equipment as it stands at present is as follows:

Station building and equipment	$19,000
Greenhouse and horticultural equipment	1,300
Old barn and equipment	1,000
New barn and equipment	5,450
Old dairy house	200
New dairy building and equipment, including loaned machinery $2,000	10,000
Office building and equipment	6,000
Cottage	600
General farm equipment, including live stock	3,600
	$47,150

Under the law, only $3,000 out of the first annual station appropriation and $750 out of each one since could be used for buildings and repairs The reports of the treasurer for each year show that only $10,618.41 has been spent in 12 years from the Hatch fund for building and repairs. Deducting this from the total amount for buildings, we have the amount of $11,447.59 provided from the general funds of the University. All of the income from the college farm goes back upon it and is used exclusively in its maintenance or the improvement of its property and equipment and aiding agricultural students. This income has varied from $1,100 to $3,000 a year. The gross returns from the farm for the year 1899-1900, were $3,769.62 and were the largest in its history.

It is impossible in so brief a space as that here allowed to describe all the work of the station during the last 12 years. Its scope will be shown in a general way by the titles of the bulletins published. The work of chief importance since the station was established has been the investigation and development of the agricultural resources of the state. Plans were early made for studying the climate and soils, the flora and fauna of Tennessee, with special reference to the development of its agricultural, horticultural, and animal industries. Among the more important published reports on this subject are those on the soils of the state, with a soil and products map, one on the grasses of the state, one on seedling apples of Tennessee origin, and one on the native grown feeding stuffs of the state.

The station commenced its survey of the soils of Tennessee in 1891. A preliminary soil map was prepared and typical samples of many of the virgin soils were collected and analyzed both chemically and physically. Notes were made at each place upon the geology, flora and fauna, agricultural methods and products. A large relief map of the state was made, colored and lettered to correspond to the geology and soils of the state. This magnificent miniature of Tennessee is preserved in the station as a subject of study.

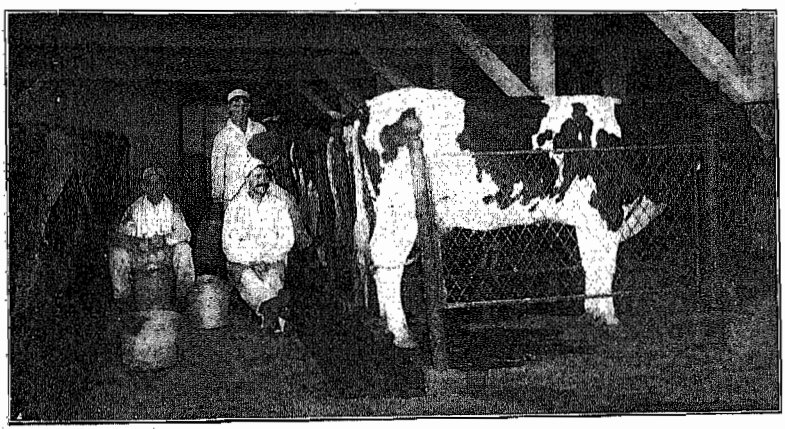
In a similar manner a thorough study has been made of the grasses of Tennessee. The results of this investigation have appeared in two reports, one upon the botanical features and the other upon the agricultural features and uses of our Tennessee grasses and forage plants. Illustrations were especially drawn for the botanical report from specimens in the station herbarium. During the progress of this work a grass garden was carried on which still exists in part.

A systematic study has been made of Tennessee seedling apples which were reported to be valuable but unknown outside of the immediate vicinity of their origin. The fruits were collected and compared and the most promising varieties were described and figured and thus brought before the public.

Among the minor crops which have been studied in like manner have been the peanut and the cowpea. The cowpea has been thoroughly studied in all its relations with other plants like corn and sorghum and as to its methods of cultivation and the best methods of using it and its several parts.

A careful study has been made of cotton seed meal and cotton seed cakes produced in Tennessee. A comparison has been made of the average composition of southern feeding stuffs and American feeding stuffs in general. A thorough study was also made of the cotton plant from the chemical point of view. Analyses were made of all the different parts of the plant, determinations of the relative amounts of each of these parts, and calculations of the fertilizer constituents contained in the average crop and of the cotton seed and its products.

Feeding experiments have been carried on at various times to determine the best method of producing beef, the average cost of milk produced by cows of different breeds under like conditions, to compare the milk yield of thoroughbred and grade cows, to compare the feeding value and effect of different feeding stuffs, especially of cowpea hay, cowpea and sorghum hay, and cowpea and maize mixed, cotton seed meal and hulls, producing both milk and beef.



INTERIOR OF DAIRY BARN

Cultural and variety tests have been made with potatoes and cereals; cooperative experiments have been carried on to determine the value of different feed stuffs, sugar beets, fruits and grains; and more recently different kinds of fertilizers have been tested upon different typical soils.

In the horticultural division cultural and variety tests have been made with small fruits, tomatoes and vegetables, grown both out of doors and under glass. Special attention has been paid to tomatoes, strawberries and grapes. A study has been made of the American and Japanese persimmons and their culture. Experiments in forcing lettuce were carried on for some years with excellent results in teaching gardeners how to grow and prepare the plant for market. A study of the wild onion, a weed which gives much trouble in some parts of the state, has been made.

Important investigations have been made on the diseases of the potato and grape and diseases of the Irish potato due to nematodes were first

described by the botanist. Prof. Scribner of this station, in cooperation with a French investigator, M. Viala, first determined the nature of the black rot of the grape and prepared the first official circular recommending the use of Bordeaux mixture published in the United States. Some of the experiments upon which these valuable reports were based were conducted at the Tennessee experiment station. For these great discoveries, now applied throughout the world, Prof. Scribner was decorated by the French government with the order of the Legion of Honor. The present botanist is making a study of the effect of various fungicides on peach foliage. The experiment station made an exhibit illustrating its soil survey, and of its grass survey of Tennessee at the Paris Exposition of 1900. Gold medals were awarded both portions of this exhibit, which, at the request of President Dabney, were issued in the names of Charles F. Vanderford, deceased, for the soil survey and Col. J. B. Killebrew, grass expert of the station, for the exhibit of work on the grasses of Tennessee.

For a number of years the station held farmers' institutes in different sections of the state wherever invited. Since August, 1899, it has cooperated with the commissioner of agriculture in holding these institutes, and during this time members of the staff have visited 30 institutes. Generally three members of the station staff give illustrated lectures at each institute. At some of them, exhibits illustrating the work of the station have been made.

PUBLICATIONS

During the 13 years since the organization of the Hatch experiment station 59 bulletins and 13 annual reports have been issued, besides many special bulletins, press bulletins, posters, and circulars. The regular bulletins and reports have contained in all 1,879 pages. The average edition of each of these publications was about 7,000 copies, not including press bulletins, which were issued in even greater editions. During the 13 years we have sent out 465,000 copies of reports, bulletins, and handbooks, not including press bulletins and specials. All of these have been distributed free of charge to Tennessee farmers whose addresses are sent in. The station has thus distributed over 13,000,000 printed pages discussing different subjects in scientific agriculture, horticulture, dairying, and animal husbandry. A list of the bulletins and reports is appended hereto. The mailing list consists of over 9,000 names.

In concluding this brief report of the work of the experiment station during the last 13 years we will quote the following judgment of the general results of its work from the report of the director of experiment stations of the United States made to the secretary of agriculture in 1900 (Bulletin 80, page 413): "The Tennessee station has performed an important work in its studies of the soils, grasses, and other natural conditions on which the agriculture of the state is based. It has shown the causes of the deterioration of soils and the methods by which they may be improved. It has promoted the diversification of agriculture by the introduction of grasses and forage plants, the extension of tobacco.

potato, and peanut growing, the development of the growing of small fruits and grapes, and the advancement of farm dairying and general stock industries. Its chemical investigations of the cotton and peanut plants and their products have been of general importance and have aided the wider use of these products as feeding stuffs. It has greatly aided the horticultural interests of the state by showing how black rot of grapes and other diseases of fruits, as well as injurious insects, may be repressed by spraying with fungicides and insecticides. It has done much to teach the farmers the discriminating use of commercial fertilizers and farm manures."

INSTRUCTION IN AGRICULTURE

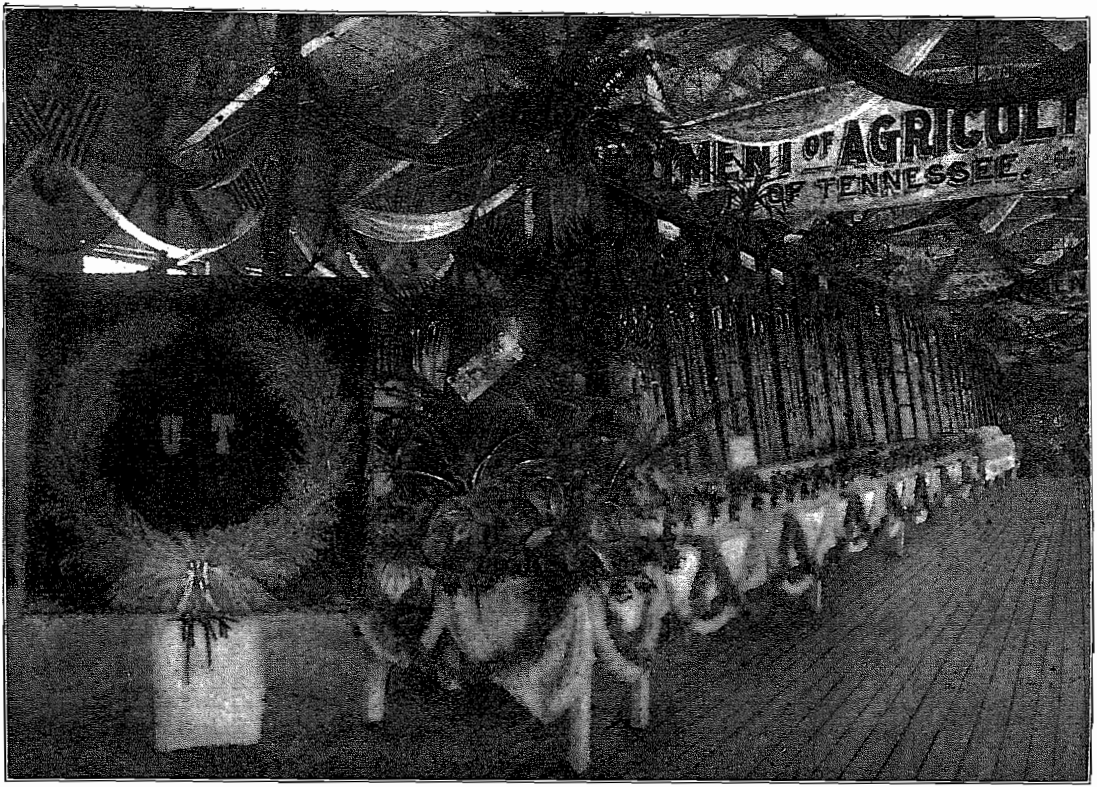
Instruction in agriculture has gone on steadily and has grown much more popular and been greatly broadened in recent years. It is unnecessary to discuss again at this place the difficulties of inducing young men to study agriculture as a profession, but the disposition to enter farm life is increasing and we were never so much encouraged as now.

These institutions were founded not merely to teach practical agriculture, but to teach all of the sciences pertaining to agriculture and the mechanic arts. It is very unfair, therefore, to measure their work by the number of students who make agriculture the special thing. Hundreds of students have studied the sciences pertaining to agriculture here during the last 12 years who will become actual farmers, although they were not planning to do so at the time. It is a matter of common observation that a great many young people try to prepare at college for the so-called learned professions or for commerce but abandon these pursuits and return to the farm after a few years. It is of some interest, however, to ascertain how many students have announced upon coming to college their purpose to study agriculture as a specialty. If we examine the list of those who studied in the schools of practical agriculture and horticulture alone, there were only 10. Our encouragement is drawn from the fact that whereas there were only 10 students in practical agriculture in 1887-'88 there were 91 who elected studies in this school during the session 1899-'00. The school of horticulture was not established as a separate one until 1897. A list of those who have studied the sciences pertaining to agriculture would include three-fourths of all the students who have attended the institution during this period.

To sum up the progress of agriculture in the University, considering the station and the department of agriculture as one, we have in the 12 years invested $47,150 for the improvement of our plant for teaching and investigating in agriculture and horticulture alone, not including the investment in chemical laboratories and other "sciences pertaining to agriculture," as against $23,438 invested in the plant for teaching mechanic arts alone. We have increased our corps of officers and instructors from seven to 13 and have increased the number of students studying practical agriculture and horticulture from 19 in 1887-'88 to 91 in 1899-'00.

CHARLES W. DABNEY, President.

December 31, 1900.



PARTIAL VIEW OF THE PERMANENT AGRICULTURAL EXHIBIT

PUBLICATIONS OF THE TENNESSEE EXPERIMENT STATION, 1882-1900

Publications	Title	Author
1882		
Report	Experiments in wheat culture, ensilage, and other crops. Top dressings on clover and grass.	J. M. McBryde.
1884		
Bulletin 1	Analyses and tests of manures and fertilizers for 1883-84.	J. W. Glenn.
Biennial Report. 1885-86	Biennial report, 1883-84.	
Report	Wheat culture and forage crops.	J. W. Glenn.
Biennial Report.	Biennial report, 1885-86.	
Biennial Report. 1888	Biennial report, 1886-87.	
Bulletin Vol. I		
No. 1	Dehorning cattle. History and reorganization.	C. S. Plumb.
No. 2	The experiment station; building and laboratories; germination of seed corn; analyses of commercial fertilizers.	C. W. Dabney and C. S. Plumb.
No. 3	Weeds of the farm.	F. L. Scribner and C. L. Newman.
Annual Report 1889	First annual report, 1888.	
Bulletin Vol. II		
No. 1	Notes on fertilizers and fertilizing materials.	W. E. Stone.
No. 2	Diseases of the Irish potato.	F. L. Scribner.
No. 3	Cotton-seed hulls and meal as food for live stock.	W. E. Stone.
No. 4	Grasses of mountain meadows and deer parks. Chemical composition and tests of varieties of strawberries.	F. L. Scribner. W. E. Stone.
Special Bulletin A	The army worm, how to prevent its ravages on cotton.	
Special Bulletin B	Analyses of commercial fertilizers.	W. E. Stone.
Annual Report 1890	Second annual report, 1889.	
Bulletin Vol. III		
No. 1	Experiment in growing potatoes.	C. S. Plumb.
No. 2	Field experiments with barley, corn, oats, wheat, sorghum and clover.	C. S. Plumb.
No. 3	Points about country roads.	W. W. Carson.
No. 4	Practical experiments in reclaiming "galled" or washed lands; notes on mulch and mulch materials.	P. F. Kefauver.

PUBLICATIONS OF EXPERIMENT STATION—*Continued*

Publications	Title	Author
1890—*Cont.*		
No. 5	Fruit trees at the experiment station.	R. L. Watts.
No. 6	Index to Vol. I, II and III.	
Special Bulletin C	The treatment of certain fungus diseases of plants.	F. L. Scribner.
Special Bulletin D	Potash and paying crops.	
Special Bulletin E	The cotton worm; the Hessian fly.	H. E. Summers.
Annual Report 1891	Third annual report.	
Bulletin Vol. IV		
No. 1	Crab-grass hay; sorghum as a forage plant; test of feed value of first and second crops of clover; pasture grasses; black knot of the plum and cherry; pruning fruit trees; the glassy winged soldier bug; diseases of live stock; experiment station record.	C. W. Dabney, et al.
No. 2	The peanut crop of Tennessee, statistics, culture, and chemistry.	L. P. Brown.
No. 3	The true bugs or heteroptera of Tennessee.	H. E. Summers.
No. 4	Some fungus diseases of the grape.	F. L. Scribner.
No. 5	A chemical study of the cotton plant.	J. B. McBryde.
Annual Report 1892	Fourth annual report, 1891.	
Bulletin Vol. V		
No. 1	Fruit trees and experiments with vegetables.	R. L. Watts.
No. 2	Grasses of Tennessee, I.	F. L. Scribner.
No. 3	A contribution to the study of the economies of milk production.	C. F. Vanderford.
No. 4	Experiments with fruit trees and vegetables.	R. L. Watts.
Annual Report 1893	Fifth annual report, 1892.	
Bulletin Vol. VI		
No. 1	Some injurious insects of the apple.	C. E. Chambliss.
No. 2	Rational use of feeding stuffs; winter dairying in Tennessee.	C. F. Vanderford.
No. 3	Small fruits; strawberries, raspberries, blackberries and grapes.	R. L. Watts.

PUBLICATIONS OF EXPERIMENT STATION—*Continued*

Publications	Title	Author
1893—*Cont.*		
No. 4	Field experiments with tomatoes and onions.	R. L. Watts.
Annual Report 1894	Sixth annual report, 1893.	
Bulletin Vol. VII		
No. 1	Grasses of Tennessee, II.	F. L. Scribner.
No. 2	Fruits: Grapes, strawberries, raspberries, blackberries, pears, applies and peaches.	R. L. Watts.
No. 3	Cooperative experimentation.	
No. 4	Dehorning cattle; notes to correspondents.	
Annual Report 1895	Seventh annual report, 1894.	
Bulletin Vol. VIII		
No. 1	Spraying apparatus.	R. L. Watts.
	Insecticides.	C. E. Chambliss.
	Fungicides; spraying calendar.	S. M. Bain.
No. 2	The wild onion.	R. L. Watts.
No. 3	Some experiments with fungicides on peach foliage.	S. M. Bain.
No. 4	The Chinch bug (blissus leucopterus).	C. E. Chambliss.
Annual Report 1896	Eighth annual report, 1895.	
Bulletin Vol. IX		
No. 1	Apples of Tennessee origin.	R. L. Watts.
No. 2	Strawberries.	R. L. Watts.
No. 3	A contribution to the study of southern feeding stuffs.	J. B. McBryde.
No. 4	Varieties of grapes.	R. L. Watts.
Annual Report 1897	Ninth annual report, 1896.	
Bulletin Vol. X		
No. 1	Apples of Tennessee origin (Second report).	R. L. Watts.
No. 2	Pot culture of lettuce.	R. L. Watts.
No. 3	The soils of Tennessee.	C. F. Vanderford.
No. 4	Scale insects: San Jose and other species.	C. E. Chambliss.
Annual Report 1898	Tenth annual report, 1897.	
Bulletin Vol. XI		
No. 1	Persimmons.	R. L. Watts.
No. 2	Grasses and forage plants: I. Domesticated grasses.	J. B. Killebrew.
No. 3	Grasses and forage plants: II. Leguminous plants.	J. B. Killebrew.
No. 4	Grasses and forage plants: III. Meadows and wild pastures.	J. B. Killebrew.
Annual Report	Eleventh annual report, 1898.	

PUBLICATIONS OF EXPERIMENT STATION—*Continued*

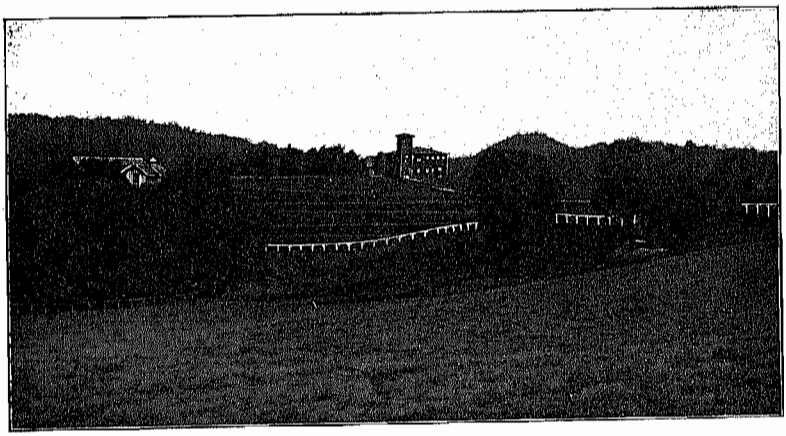
Publications	Title	Author
1899		
Bulletin Vol. XII		
No. 1	Stock interests.	Andrew M. Soule and George A. Flickinger.
No. 2	Soil and fertilizers.	Andrew M. Soule and Chas. A. Mooers.
No. 3	Horticultural work.	Charles A. Keffer, Chas. A. Mooers and R. H. Garrahan.
No. 4	Forage.	Andrew M. Soule, John R. Fain and Phares O. Vanatter.
Annual Report	Twelfth annual report, 1899.	
1900		
Bulletin Vol. XIII		
No. 1	Frost protection. Climate of Tennessee.	Weston M. Fulton.
No. 2	Experiments with winter wheat.	Andrew M. Soule and Phares O. Vanatter.
No. 3	Fertilizer experiments on potatoes, corn, cowpeas, peanuts.	Chas. A. Mooers. Andrew M. Soule.
No. 4	Feeding native steers.	Andrew M. Soule and John R. Fain.
Annual Report	Thirteenth annual report, 1900.	

PRESS BULLETINS

Publications	Title	Author
1899		
No. 1	Value of leguminous plants.	Chas. W. Dabney.
No. 2	Home-made fertilizers.	Chas. W. Dabney.
No. 3	Farmers' institutes.	R. L. Watts.
No. 4	How the experiment station can help the farmers.	R. L. Watts.
No. 5	The East Tennessee farmers' convention and farmers' institute.	R. L. Watts.
No. 6	Sheep husbandry. (Condensed by R. L. Watts from address of Thos. W. Jordan).	
No. 7	The saving of soil moisture.	Andrew M. Soule.
No. 8	Farmers' institute to be held at Boons Creek, Washington county, Tenn., Tuesday and Wednesday, August 22 and 23, 1899.	R. L. Watts.
No. 9	Liming soils.	Chas. A. Mooers.

PRESS BULLETINS—*Continued*

Publications	Title	Author
No. 10	Farmers' institute to be held at Rogersville, Hawkins county, Tenn., Friday and Saturday, August 25 and 26.	R. L. Watts.
No. 11	The fertilizer question.	Chas. A. Mooers.
No. 12	Cowpea vine hay.	Andrew M. Soule.
No. 13	A short course in agriculture.	Andrew M. Soule.
1900		
No. 14	Grades on country roads.	W. W. Carson.
No. 15	Calf feeding.	Andrew M. Soule.
No. 16	Live stock problems.	Andrew M. Soule.
No. 17	Winter gardening. Winter violets.	Charles A. Keffer.
No. 18	Advantages of dairying.	Andrew M. Soule.
No. 19	Formulas for spraying mixtures.	Samuel M. Bain.



FARM TERRACES AND DORMITORY

REPORT OF THE AGRICULTURIST

The work of the agricultural division of the Tennessee experiment station is chiefly conducted on the University farm and is divided under three principal heads, namely: 1 Plat experiments and field trials with grain. 2 General farm work and stock feeding. 3 Dairy husbandry.

The present system of field trials and plat experiments was commenced on the University farm in the fall of 1899, the object being to study the relation and adaptability of the several farm crops to the soil and climate of Tennessee. The work of this division is incorporated under four principal heads:

1 Experiments with winter cereals, including wheat, barley, oats, rye, etc.

2 Experiments with forage crops, including corn, sorghum, teosinte, rape, millet, cowpeas, soja beans, velvet beans, etc.

3 Experiments with grasses and clover.

a Clover variety tests, methods of seeding, culture of clover with different cover crops.

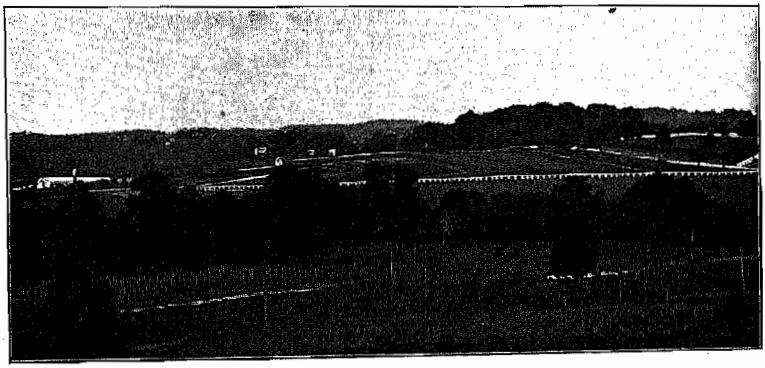
b Grasses: Variety tests, mixtures for hay, pasture and lawns.

4 Experiments in soil restoration, including a rotation of crops, the use of green manures, application of commercial fertilizers, and the utility of barnyard manure, etc.

The growth of winter cereals in this state is a question of vital concern to our farmers. One principal line of work undertaken is with winter wheat, including tests with local and foreign varieties, the influence of dates of seeding, different methods of seeding and cultivating, interchange of seed to and from the different soil types of the state, seed selection and plant breeding. Farmers are of the opinion that they must change their seed every year or two as it runs out. If selection is properly carried on, the seeds of farm crops will not run out and a variety of wheat can be maintained on the same land for years, and when a variety well adapted to one section is secured, its preservation means dollars and cents to the farmers. The past year it was found that 1200 large heads of wheat contained 35,412 grains, with 29.5 grains to the head and 736 grains to the ounce, with a total weight of two pounds, 15⅛ ounces; 1600 medium heads of wheat contained 25,623 grains with 16.07 grains to the head and 797 grains to the ounce, with a total weight of two pounds, 5-16 ounce; 3200 small heads of wheat contained 27,643 grains, with 8.64 grains to the head and 909 grains to the ounce, with a total weight of one pound, 14 7-16 ounces. Here it is seen that 1200 large heads produced about one pound and one ounce more grain than 3200 small heads; that the large heads contained 29½ grains per head as compared with 16.1 grains in the medium heads and 8.6 grains in the small heads. Indifferent seed would thus often explain why the farmer secures such a small yield of wheat per acre. In the bulletin on wheat published last year, it was found that the average variety grown by the farmer produced from 12 to 15 bushels, whereas some varieties produced 40 bushels per acre. The average yield

of wheat in Tennessee is about 8.7 bushels per acre, yet many farmers secure 30 to 40 bushels per acre. Tennessee is admirably adapted to the production of winter wheat and instead of securing 8,292,727 bushels from 953,187 acres of land, at least three times this amount of wheat could be grown on this area if the question of the utility of the various varieties were understood and the proper methods of culture and seed selection practiced.

The University farm comprises about 105 acres, of which 70 acres are devoted to the culture of farm crops on an extensive scale and the working out of various problems of general agricultural interest. The following lines of investigations are being pursued in this division of the work. A study of crops adapted for ensilage production, including corn, sorghum, teosinte, cowpeas, etc. It is the purpose of this work to determine the cost and relative value of ensilage from corn, corn and peas, sorghum, and sorghum and peas, etc.; to determine the amount of nutrients derived from an acre of the respective crops, the cost of producing the same, the total yield of the crop secured per acre, and the utility of these crops for



THE EXPERIMENTAL PLATS, UNIVERSITY FARM

the production of meat, milk, etc. As an immense growth of sorghum can be produced after a crop of winter cereals and as it is rarely affected by drought and can certainly be made into a most excellent quality of ensilage, it is of the utmost importance that its full feeding value be ascertained as soon as possible.

A rotation of crops is practiced on the farm for the purpose of building up the soil, and last year two crops were produced in a single season on more than forty acres of the area devoted to this work. As a rule, but one crop is produced in Tennessee and that is often of indifferent quality. Besides demonstrating the fact that two crops should be grown, it illustrates the value of intensive farming, as more than fifty head of stock have been maintained for a year on the roughness in the form of hay, ensilage, etc., produced on this 70 acres of land. If our farmers would give more attention to the proper culture of the soil and confine their areas within smaller limits, it would be vastly better for them.

During the season of 1900 eight native steers were fattened at the experiment station. They were of the ordinary type and yet gratifying results were obtained in that from $6 to $10 apiece was cleared after liberal allowances had been made for care, feeding, etc. The experiment demonstrated that cattle can be fed at a profit on a home-grown ration on Tennessee farms and it emphasized the fact that pea vine hay has an exceptionally high feeding value. In the slaughter test our animals dressed about 55 per cent and they were much superior to the cattle ordinarily slaughtered in the Knoxville abattoir. The so-called beef cattle of Tennessee will hardly dress 50 per cent, though there are today 286,841 head of cattle in this class. These animals should dress 60 per cent and the offspring of a first cross with an improved sire would easily do this. If we consider the average weight of these animals as 700 pounds, it means a loss of 20,078,870 pounds in slaughtering, which at the low estimate of three cents a pound amounts to $603,166.10. Tennessee farmers are sim-

THE DAIRY HERD

ply throwing away this amount of money because of a failure to study this important question, and it is safe to say that if the cross indicated above were made the profit from feeding beef cattle could be easily doubled. This year an experiment with 15 head of cattle is being carried on and in the 60 days of the experiment expired, they have gained 1,457 pounds. The animals are divided into four groups and are being fed on four distinct rations for the purpose of studying their utility and profit for beef production. The importance of studying these feed stuffs is evident as the animals in one group gained 143 pounds in 60 days, while the group on ensilage gained 450 pounds. The cost of the ration will measure the profit derived from feeding in every instance. Hence, it stands to reason that a man who has studied animal anatomy and physiology and understands assimilation and nutrition, has some chemical knowledge of food stuffs and knows how to buy and blend feeding nutrients is in a position

to feed cattle in the most economical way and to make a profit even when circumstances are against him.

Feeding experiments with swine have been commenced this year for the first time with 12 grade Chester white hogs. They are divided into four groups, being fed corn meal and water (the common farm ration in Tennessee) skim milk and corn meal; whey, wheat meal and corn meal; and skim milk, shredded pea vine hay and corn meal. In the 30 days of this experiment these animals gained 706 pounds, the highest gain being made by Group III and the next highest by Group IV, the next by Group II and the smallest by Group I. The results of this experiment have not been worked out as yet, but they demonstrate beyond question the necessity of studying swine feeding from a rational standpoint and they indicate that it can be made a profitable business where conducted on an intelligent basis.

The third line of investigation carried on at the University farm relates to dairy husbandry. A herd of 30 cows is maintained for the purpose of carrying on feeding and breeding experiments to determine the utility and value of the various forage crops produced on the farm and to study the feeding value of the various forms of ensilage previously referred to. An accurate record is kept of each cow and composite samples of milk are preserved so that the amount of butter fat yielded can be determined on specific occasions. The milk is weighed night and morning and carefully recorded and the profit to be secured from milk or butter dairying can thus be ascertained. The dairy industry of Tennessee is comparatively undeveloped, though the climate, water supply and products of the soil all combine for its admirable adaptability to the state, and as most of the failures to conduct the dairy business successfully are due to a lack of education and proficient dairymen, the investigations being carried on at the University farm have a vital significance. Experiments already completed show that a pound of butter can be produced for 12 cents and a gallon of milk for 8 cents. It cost to feed a cow 10 to 14 cents per day and equally good results have been obtained from feeding a home-grown ration as compared with one where a good portion of meal adjuncts were bought off the farm. It may be stated that a year and a half ago milk sold in Knoxville for 16 cents a gallon and today it is selling for 25 cents, and in the near future it will sell for 30 cents. The University farm is working in harmony with the dairymen of the state and almost every day it is visited by the local dairymen who are delighted and pleased with the work being carried on. This work has helped them to increase materially the profits of their business.

The present equipment of the division is fairly satisfactory, though it does not answer all the demands of the work. The agricultural building, known as Morrill Hall, is badly crowded and barely suffices to house the library and offices of the various departments of the station. It does not permit of the development of laboratories commensurate with the present status of the work, and as it serves the double purpose of experimental work and agricultural education, it is sadly in need of enlargement.

On the University farm the new dairy barn answers every purpose for which it was designed, but there is no proper place for carrying on

feeding experiments. The new dairy building is already crowded, and there is not sufficient room in it for carrying on experimental investigations together with the instructive work required. A large and convenient soil physics laboratory with a small greenhouse for the investigation of the physical properties of the soil is essential to the welfare of the work, and it certainly seems that the station should be able to maintain a number of the improved breeds of cattle, sheep and swine beside the present dairy herd. The department can not hope to develop and properly serve the state without additional equipment for its work.

Very respectfully,

ANDREW M. SOULE, Agriculturist.

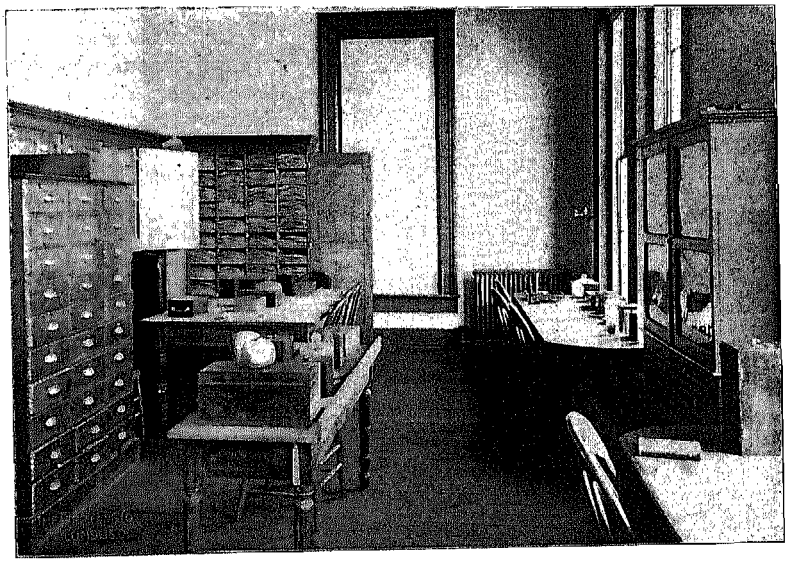
SORGHUM AND COWPEAS AFTER WINTER RYE

REPORT OF THE BOTANIST

Botany is the science relating to the plant kingdom. It includes a consideration of all facts relative to the plant itself or its method of life. Necessarily every salient feature of the plant's life has some relation, directly or remotely, to practical agriculture.

The botanical course in the University of Tennessee has been developed with special reference to practical instruction in plant physiology, the diseases of plants, and relationships of plants. The relation of the plant to the soil is taught in detail. The student is taught to recognize the various causes of plant diseases especially, and the remedies for them so far as known.

It would be hard to specify any special relation to the industrial



BOTANICAL LABORATORY—HERBARIUM ON LEFT

development of the state's natural resources, since the knowledge of the plant's method of life is so intimately connected with every agricultural pursuit, but especial reference may be made in this connection to the treatment of plant diseases and its relation to the development of the horticultural interests of the state.

The instruction in botany makes up an essential part of the general course in agriculture as given in the University, and much that has been said with reference to agriculture as a whole applies to the instruction given in botany. Necessarily much of the instruction as well as the investigation along these lines is technical and requires the use of costly and delicate apparatus and equipment. It is believed that no institution in

the south has better facilities for instruction in this important fundamental science than the University of Tennessee. Special mention may be made of the library, which is quite rich in valuable botanical works; the large collection so rich in representations of the Tennessee flora; and the botanical laboratory fitted up for individual student's work.

The experimental research of the botanical division has been for several years confined to one special line. It is believed that in this way much more has been accomplished and still greater results may be expected in the future as the work develops.

Much correspondence with different farmers in the state has been carried on, and specimens of the native plants as well as weeds and various diseases have been gathered in this way, and many valuable data collected for future use. Several years ago in looking over the field of plant diseases in the state of Tennessee, at the suggestion of the horticulturist of the experiment station, the botanist undertook an investigation of the disease commonly known as peach rot, and has confined all of his spare moments since that time, outside of instruction work, farmers' institute work, and various other duties connected with his position, to a study of this difficult question. It is hoped that during the incoming season practical field tests of results obtained in the laboratory and greenhouse may prove of great value to the fruit growers of the state. In this connection it may be mentioned that the botanist of the Georgia station estimated that during the season of 1900 the fruit growers of Georgia lost between $500,000 and $750,000 due alone to the ravages of this disease. Much advancement has been made within the last 25 years in our knowledge of plant diseases and methods of their treatment. No practical and effective methods are known for the treatment of many of our worst diseases such as pear blight, wheat rust, etc. This important work has great possibilities, and it is believed that no more important line of investigation could have been taken up by the experiment station. In the course of this work many valuable pieces of apparatus have been accumulated, some of them designed by the botanist, nearly all being of permanent value. Care has been taken to spend no money that was not needed at the time for practical work.

In connection with the special work in the investigation of fruit diseases some considerable outside work has been done, especially with reference to certain insects. Special mention may be made of the investigation of certain raspberry insects and the woolly aphis of the apple in the neighborhood of Columbia, Tennessee, and the discovery of an injurious insect on asparagus in the vicinity of Memphis.

On the whole the prospect for the accomplishment of results of vital importance to the agriculture of the state seems especially bright in this direction.

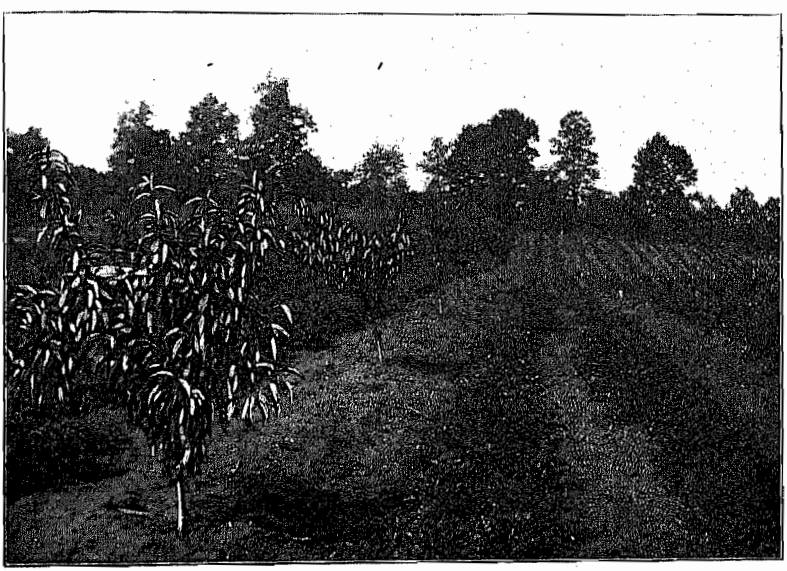
Respectfully submitted,

SAMUEL M. BAIN, Botanist.

REPORT OF THE HORTICULTURIST

On assuming charge of the work of horticulture and forestry in the University on January 3, 1900, I found in progress a most interesting and valuable investigation into the merits of seedling apples of Tennessee origin and their adaptability for general culture. My predecessor, Professor R. L. Watts, had collected trees of 44 such seedlings and had planted them in the most available site to be had on the University farm. As the University farm was needed for the field work of the department of agriculture and a much better site for horticultural operations was afforded on another tract of land belonging to the University, this department was assigned a sufficient acreage on the "north farm," for present and future needs.

The new location is a desirable one for experiments in fruit and vege-



GENERAL VIEW OF FRUIT ORCHARD

table culture, and also affords means of illustration for forest study. It includes the crest and sides of a ridge extending east and west, with its eastern terminus within the property. There is thus afforded northern, eastern, and southern slopes, with almost level land on the north, east, and south sides of the ridge. The valleys which separate this ridge from those adjacent open upon the Tennessee river, provide air drainage. The strata of underlying shale lie vertical to the surface, insuring good soil drainage.

As soon as the assignment of land to the department was made, three acres lying on the north slope and reaching to the crest of the ridge were

cleared, and with two acres of old land to the north were planted to fruits. The plantation includes, besides the 44 varieties of seedlings mentioned above:

70 trees in seven varieties of apples.
120 trees in 12 varieties of peach.
80 trees in eight varieties of pears.
50 trees in five varieties of plum.
30 trees in three varieties of cherry.
40 trees in four varieties of quince.

Between the rows on the crest and higher slope representative collections of strawberries, raspberries, blackberries, currants, and gooseberries were planted.

Throughout the season the orchard has received the best of care, and the growth made by the trees is very satisfactory. Less than two per cent were lost, and these were, with one exception, of two varieties. The fences around the fruit farm have been put in thorough repair, and the plantation enters the winter in excellent condition.

The division has purchased during the year a good equipment of tools and implements, making it for the first time independent of the division of agriculture, to whom it had long been under obligations for the use of necessary machinery. The equipment purchased includes plows, cultivators, and harrows of various types, seed drills, hand cultivators, pruning, grafting and budding supplies, and greenhouse conveniences.

The location of the new Barbara Blount Hall made the removal of the greenhouse necessary and the opportunity was used to rebuild its work rooms, to the great improvement of the plant. The greenhouse now stands in the garden on the slope below the new Barbara Blount Hall. The sloping land between Science Hall and the new building has been laid off for a rose garden. Considerable additions have also been made to the ornamental plantations in the campus.

The correspondence of the division covers a wide range, both as to territory and subjects. Frequent inquiries of the horticultural interests of the state are received from citizens of northern states who are seeking a location in a milder climate. In several instances parties have made personal inspection following such correspondence. Citizens of Tennessee are more and more availing themselves of the station as a source of information on horticultural subjects.

During the year farmers' institutes have been attended in Gibson, Carroll, Hamblen (3), and Monroe counties, and also the annual meeting of the East Tennessee horticultural society at Harriman. At all these meetings the keen interest manifested in horticultural topics warranted the belief that the work of this division will be increasingly appreciated as it is extended. During the growing season weekly press bulletins on horticultural topics suggested by the work at the station were sent to the newspapers of the state, and their very general publication is a source of satisfaction to the division, indicating widespread interest and appreciation.

Respectfully submitted,

CHARLES A. KEFFER, Horticulturist.

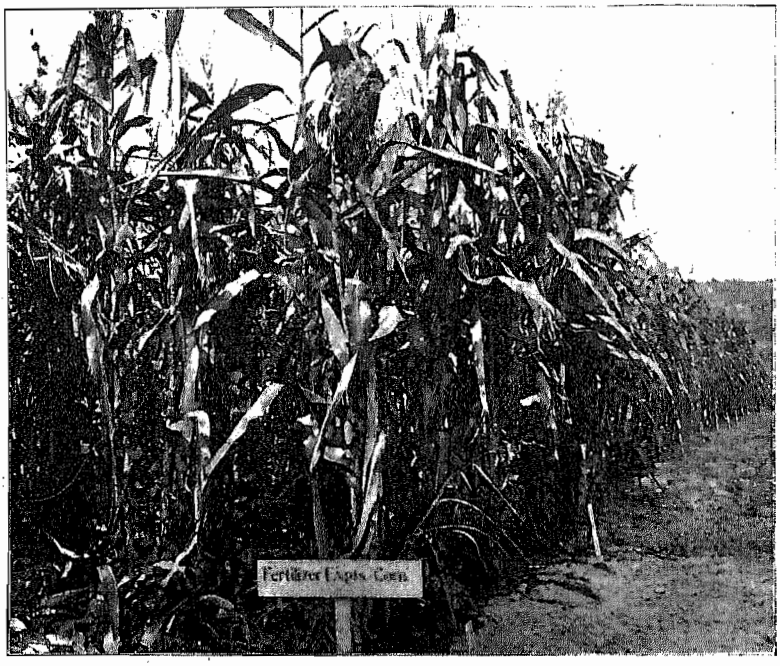
REPORT OF THE CHEMIST

The following report of the work of the chemical division of the experiment station for the year 1900 is respectfully submitted:

The principal line of work has been a study of some of the most important types of soils with particular reference to their fertilizer requirements. To this end, some time has been spent in the collecting of soil samples, analyses of which have for the most part not been made. In connection with the soil analyses some cooperative field experiments with fertilizers were carrired out, but to a much more limited extent than was desired. Most of the farmers at distant parts of the state who expressed a desire to cooperate in this way failed for various reasons to carry out the experiments even after the fertilizers had been sent to them. Nearly fifty per cent of all the experiments which were conducted near Knoxville and which received the personal supervision of the chemist were ruined either by dry weather or by the unequal fertility of the different experimental plots, which inequality at the time the plots were selected could not be foreseen. The most important and trustworthy results from the season's work have been published as Bulletin 3 of Volume 13. In this bulletin are the results of experiments on three important types of soils, the blue limestone, the cherty dolomite, and a river bottom soil. Some chemical work both on the soils and on the crops is also published there. In addition to testing for the special requirements of these soils experiments were made to determine the relative fertilizer values under field conditions of the nitrogen of cotton-seed meal and of nitrate of soda, and other experiments were made to determine whether the use of a nitrogenous fertilizer either for cowpeas or for peanuts was advisable. Another series of experiments was carried out to test the effects of fertilizers on the germination of seed, with particular reference to the present practice of drilling wheat and fertilizer together. While conclusive results from field experiments can not be hoped for in a single season those published were thought to be worthy of consideration by Tennessee farmers, for whom they were primarily intended.

That there is a widespread interest in the subject of fertilizers is proved by the questions which come from all parts of the state. While there may be areas in Tennessee where fertilizers are not needed in order to produce even maximum crops, it is probable that on the majority of the upland farms a judicious use of fertilizers would be profitable, and there are some large sections, the Cumberland Plateau, for example, where fertilizers or manures are a necessity in order to get even moderate yields. Farmers have almost deserted the cherty dolomite ridges of East Tennessee because of their unproductiveness. At the same time, judging from results already obtained, this kind of soil can be economically brought to a high state of fertility by means of mineral fertilizers and cowpeas. There is therefore a great and growing demand for information on the subject of soil fertility. The fertilizer mixtures sold throughout the state are not and can not be expected to be well adapted to all the varied conditions. That the solution of the problem of profitably increasing the

fertility of upland soils is sure to follow laboratory work supplemented by intelligent, systematic, and continued field experiments with fertilizers is not doubted. To carry out a work of such fundamental importance will demand a great amount of laboratory work and cooperative field experiments. The results of this season's effort at cooperative work with farmers indicate that they will not undertake the somewhat complicated experiments advocated in the report of last year. It is now planned to get cooperation in the carrying out of very simple experiments for example to find out first of all what returns can be gotten from a high grade complete fertilizer and next whether potash can be profitably omitted. These experiments demand only three plots, one blank and two plots for the



FERTILIZER EXPERIMENTS ON CORN

fertilizers. There could be practically only one simpler series which would be to omit the plot fertilized without potash. The plant for the coming year is to carry out as many cooperative experiments as possible both at a distance and on the typical soils in this vicinity, and to make with these experiments chemical analyses of the soils.

Another problem of importance which we wish to undertake is the increasing of the starch content of Irish potatoes, as suggested by the work of the past season. Still another line of work in which some results have been already obtained is a comparison of some of the most important leguminous crops, such as cowpeas, velvet beans, and soja beans.

with respect to their ability to gather nitrogen from the air. That is, which one when grown for a soiling crop would furnish most nitrogen to the soil, or if to be used as a feed would produce the most protein. Of course conclusive results can only be obtained after several seasons' work.

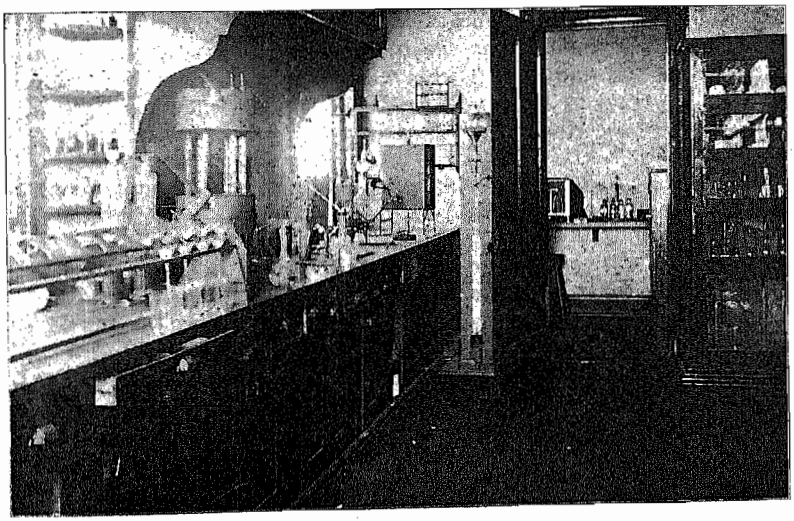
The following is a summary of the analytical work:

MATERIALS	NO. OF ANALYSES
Soils	6
Mineral waters	8
Potatoes	10
Corn (kernels)	12
Sorghum	2
Miscellaneous feeding stuffs	7
Fertilizer materials	8
Minerals sent in for examination	88

In addition to the above some time has been profitably spent in working out laboratory methods better adapted to the work in hand than those which are commonly used.

Respectfully submitted,

CHAS. A. MOOERS, Chemist.



AGRICULTURAL CHEMISTRY LABORATORY

REPORT OF THE LIBRARIAN

The library of the experiment station contains about 2,350 volumes, treating principally of general agriculture, agricultural engineering, animal industry, cereals and grasses, chemistry, geology, botany, horticulture, forestry, zoology and entomology. Among this number is a good collection of government and state reports of various kinds, over 150 of which were donated the past year by the president of the University.

The primary object of the library is to furnish references for the use of the experiment station staff in their scientific investigations, and hence a large proportion of the books are of a technical character. There are, however, some popular works which are made use of by agricultural students.

About 100 periodicals are received, which may be similarly divided into technical and popular. The former, which are chiefly subscribed for, consist of standard scientific journals of Germany, France, England and America, devoted to agriculture and related subjects. Most of those in the latter class, which includes a majority of the papers received, are sent to the station in exchange for bulletins. Among these exchanges are almost all of the best agricultural and horticultural papers of this country. They are of special value to students of agriculture and are also freely consulted by members of the station staff. Many miscellaneous papers on subjects related to agriculture are also on file.

Bulletins and reports from the other experiment stations and the United States department of agriculture are on file and can be readily referred to by means of indexes prepared at Washington. Publications of the departments of agriculture of Ontario and Ottawa, Canada, are also accessible. When extra copies of bulletins from other stations are received they are filed by subjects, to be mailed, like our own publications, to persons writing for such information as they contain.

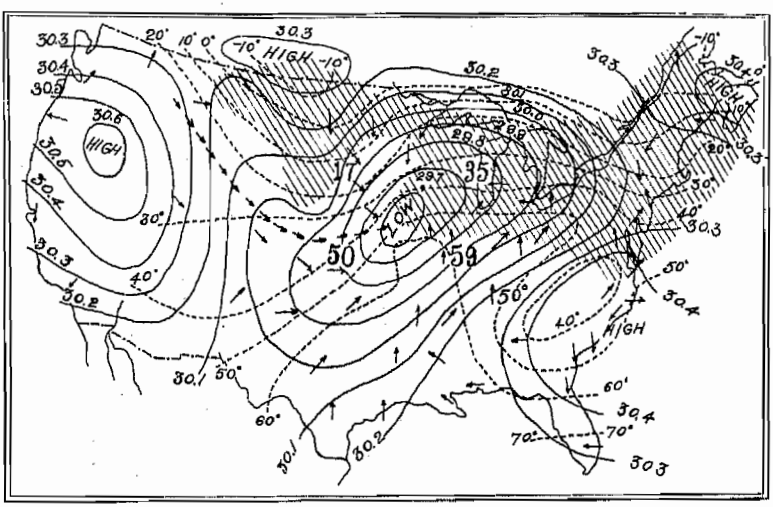
The bulletin mailing list consists of over 9,000 names. This is an increase of over 6,000 within two years. In 1899 and again in 1900 circular letters were enclosed with bulletins to all persons in the state whose names were then on our list asking them for the names of farmers and others who in their judgment would appreciate the bulletins of the station. The names of several thousand persons were thus secured, to whom specimen bulletins were mailed with a card which was to be returned in case they wished to have the bulletins regularly. In this way and through correspondence the mailing list has made the rapid growth noted, practically all persons who now receive our bulletins having made personal application for them.

Respectfully submitted,

F. H. BROOME, Librarian.

THE USE OF DAILY WEATHER CHARTS

With the growth of science and the advance of civilization, our national weather service is becoming more efficient. It is seeking to benefit agriculture along many lines. Besides the publication of weather forecasts, charts, bulletins, etc., a large amount of climatic data is being collected, and the study of these data is gradually establishing a closer relation between climate, soil and plant life. As fast as new discoveries are made they are reduced to practical form and placed in the hands of the farmer. This progress of applied weather science may be compared with that of improvement in farm implements. When any new agricultural implement is placed upon the market, the object for which it is designed, its construction, the manner in which it operates—all of these particulars



WEATHER CHART—8 P. M., DEC. 15, 1893

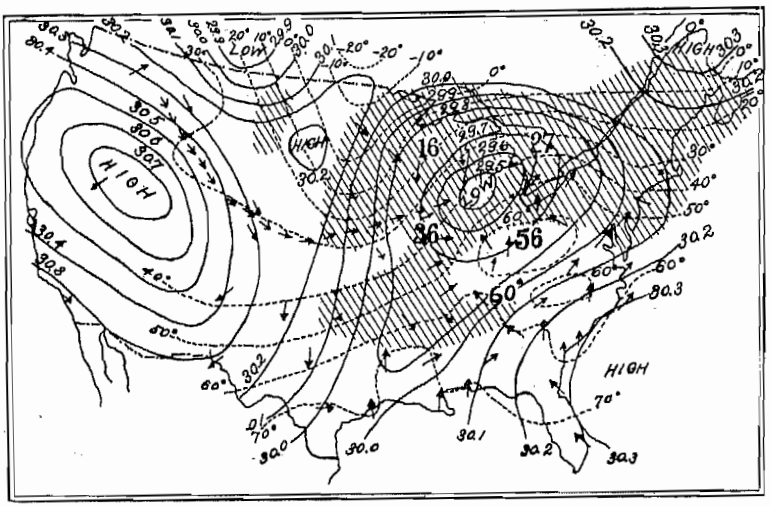
must first be explained to the farmer before he can make intelligent use of it. So is it with the publications of the weather bureau. They must be understood before they can be of value. This is especially true of the daily weather charts. Through the recently inaugurated rural delivery system of our postal service, these charts find their way to nearly every postoffice in the state, and they are there posted conspicuously so that they may be consulted by the intelligent farmer when he goes for his daily mail.

It is proposed, in the present article, to explain briefly the objects for which the weather charts are designed, the method of their construction, and in short to impart such information as may open the way to a clearer understanding of this subject on the part of the intelligent reader. The

study of the charts is like learning a new language, and it at first costs some labor, but when once the lines and symbols are understood there is a pleasure in reading them which compensates for the labor expended. If some one in each family will take the trouble to study the charts from day to day, it will not be long before every member can take an interest in them, and they will at length be found as indispensable on the well regulated farm as some of the implements used in tilling the soil, or in harvesting the grain.

OBJECT OF THE DAILY WEATHER CHARTS

The charts contain a variety of information. For one thing they show weather conditions over a large portion of the United States, and thus



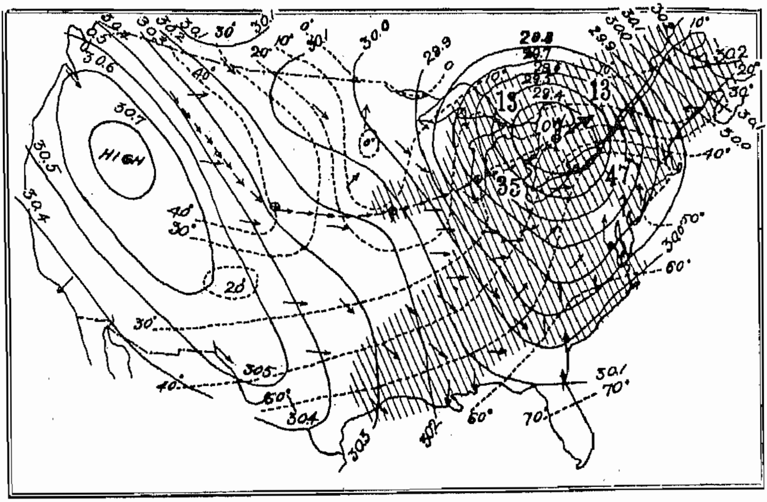
WEATHER CHART—8 A. M., DEC. 16, 1893

keep the people of one section posted relative to conditions prevailing elsewhere. They also contain a weather forecast for the 36 hours following the date of issue. But of greater importance still, perhaps, is the fact that they furnish information from which each individual citizen may often foresee coming weather changes for himself, and thus act with greater intelligence in making use of the forecasts. These facts will be appreciated more fully after reading the following description of

HOW DAILY WEATHER CHARTS ARE CONSTRUCTED

The weather bureau has about 150 observatories which are equipped with apparatus for observing weather conditions. These observatories are well distributed throughout the entire United States, the West India Islands and the northern coast of South America. Trained observers are on duty at the observatories, and at least twice each day (8 a. m. and 8 p. m., 75th meridian time) the observers make observations of atmospheric

pressure, temperature, wind velocity, wind direction, humidity, dew-point, vapor pressure, rain, snow, ice, frost and clouds with their kind and direction. This information is quickly enciphered into a short message which is transmitted by telegraph to the Central office at Washington, D C. In the case of the 8 a. m. reports, each observatory receives in return for its report, the reports from a number of other observatories. This is accomplished by means of an ingenious system of telegraph circuits, so that nearly all observatories receive a sufficient number of reports from other observatories to justify the issuing of a daily weather chart. The charts issued from these observatories are the ones most extensively distributed throughout the country, since those from the Washington office could not be received by mail early enough to be of value. Those issued from the weather bureau observatory at the Tennessee agricultural experiment



Weather Chart—8 p. m., Dec. 16, 1893

station are distributed in this section of Tennessee. The following remarks which apply to the construction of daily weather charts at this observatory will also apply in a general way to the charts issued elsewhere:

As soon as the telegraphic reports from other observatories are received here, the barometric pressures, temperatures, wind directions, etc., are written upon an outline map of the United States at the respective stations to which the data belong. Solid lines, called "isobars," are then drawn connecting all points having the same pressure, a line being drawn for each tenth of an inch of pressure. Next are drawn dotted lines, called "isotherms," connecting all points having the same temperature, a line being drawn for each ten degrees. Arrows are placed at the reporting stations showing the direction of the wind; the arrows fly with the wind, or opposite to the ordinary wind-vane. The state of the weather—whether

clear, partly cloudy, cloudy, raining or snowing—is indicated by the circular symbol. Sometimes a shading is placed upon the chart to show regions over which rain has fallen during the preceding 24 hours. The regions of highest and lowest pressure are marked "high" and "low" respectively. The "lows" are storm centers, while the "highs" are centers of clear, cool or cold, weather. The general movement of these lows and highs is from west to east similar to a series of atmospheric waves of which the highs form the crests while the lows form the troughs or depressions. These highs and lows have an average easterly movement of about six hundred miles per day. High winds, with rain or snow, usually precede the low area, often extending to a distance of 600 miles to the eastward of the center of the storm. In advance of the low the winds are generally southerly, and consequently bring high temperature. When the center of a low passes to the east of a place the wind at once shifts to the west or northwest, bringing lower temperature. The temperature on a given parallel of latitude west of the low may be reasonably looked for on the same parallel to the east when the low has passed, and frost will occur along and north of an isotherm of about 40 degrees, if the night is clear and there be but little wind. Following the low usually comes an area of high, bringing sunshiny weather, which in its turn is followed by another low.

By bearing in mind a few general rules as to the direction and rate of movement of the low and high, with the blowing of the wind from the high toward the low, and studying the map carefully, coming weather changes may frequently be foreseen. The centers of lows do not, as a rule, move across isotherms, but follow their general direction. Areas of low pressure frequently move to the south of east from the Rocky Mountains to the Mississippi and then change direction to the north of east over the eastern half of the country. Storms in the Gulf of Mexico occasionally move to the west or north of west, but after reaching the coast, they generally change direction and move to the northeastward. High areas move to the southeast and are usually attended by fair and cool or cold weather. A cold wave is always accompanied by a high.

The cloud and rain area in front of a low is generally about the size of the latter and oval, with the west side touching the center of the low in advance of which it progresses.

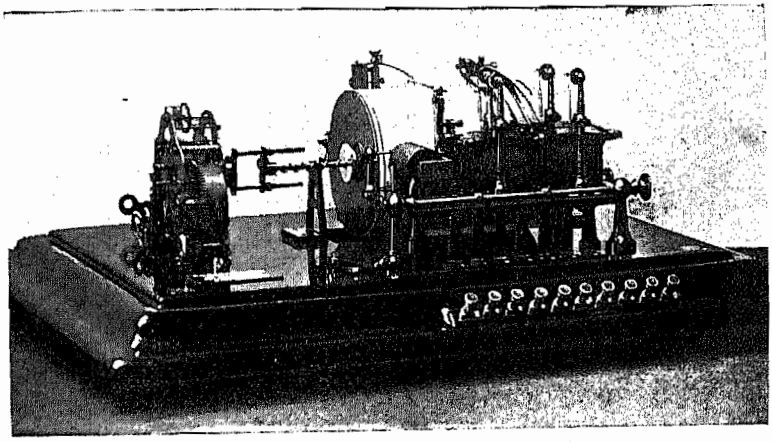
When the isotherms run nearly east and west no decided change in temperature will occur. If the isotherms directly west of a place incline from northwest to southeast, it will be warmer; if from northeast to southwest, it will be colder. Southerly to easterly winds prevail west of a nearly north and south line passing through the middle of a high, also east of a like line passing through the middle of a low. Northerly to westerly winds occur west of a nearly north and south line passing through the middle of a low, and also east of a similar line through the middle of a high.

An absence of decided waves of high or troughs of low pressure indicates a continuance of existing weather conditions which will last till later maps show a change, usually first appearing in the west.

The accompanying illustrations give charts whereon is shown the actual conditions which existed at 8 p. m. of December 15, 1893, and at 8 a. m. and 8 p. m. of the following day, during the passage of a winter storm across the United States at that time.

The foregoing remarks must not be construed as an attempt at a complete discussion of these atmospheric movements. The detailed study of these constitutes quite an extensive branch of meteorological science. It is, however, hoped that these few simple remarks will stimulate closer study of the weather charts. Such study is sure to reveal many interesting laws regarding weather changes which can be turned to practical account by the farmer.

W. M. FULTON, Meteorologist.



METEOROGRAPH

TREASURER'S REPORT,

JULY 1, 1899 TO JULY 1, 1900

The Agricultural Experiment Station of the University of Tennessee,

IN ACCOUNT WITH THE UNITED STATES.

	Dr.	*Cr.*
To unexpended balance on hand July 1, 1899	$ 18 34	
July 5, to United States treasury draft, 1899	3,750 ..	
Oct. 7, to United States treasury draft, 1899	3,750 ..	
Jan. 6, to United States treasury draft, 1900	3,750 ..	
April 6, to United States treasury draft, 1900	3,750 ..	
By Salaries		$ 6,662 29
Labor		2,978 02
Publications		1,008 27
Postage and stationery		241 11
Freight and express		100 50
Heat, light and water		315 04
Chemical supplies		35 ..
Seeds, plants and sundry supplies		375 35
Fertilizers		110 21
Feeding stuffs		323 31
Library		176 54
Tools, implements and machinery		998 93
Furniture and fixtures		12 ..
Scientific apparatus		201 36
Live stock		600 ..
Traveling expenses		364 75
Contingent expenses		98 27
Building and repairs		399 05
Balance		18 34
Totals	$15,018 34	$15,018 34

This is to certify, that, as the authorized auditing committee of the board of trustees of the University of Tennessee, we have examined the accounts of the treasurer of the agircultural experiment station for the fiscal year ending June 30, 1900, and find them correct; that the above is a true balance sheet corresponding with said accounts; that the said accounts show no more than $399.05 was expended for building and repairs, and that there is $18.34 cash balance.

EDWARD T. SANFORD,
JAMES MAYNARD,
HU L. McCLUNG,
Auditing Committee.

We hereby certify that Edward T. Sanford, James Maynard and Hu L. McClung are the authorized auditing committee of the board of trustees of the University of Tennessee.

CHAS. W. DABNEY,
President University of Tennessee.
J. W. GAUT,
Secretary Board of Trustees.

State of Tennessee, County of Knox.

Before me, Thos. D. Morris, a Notary Public in and for said State and County, personally appeared the foregoing signers, personally known to me to be trustees and officers of the University of Tennessee, who made oath, in due form of law, that the above statements are true to the best of their knowledge, information and belief.

Witness my hand and official seal at office in Knoxville, Tennessee, this 21 day of February, 1901.

THOS. D. MORRIS.